

Further notes on the turrilitid ammonoids from Hokkaido— Part 1 (Studies of the Cretaceous ammonites from Hokkaido and Sakhalin—LXXXIX)

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Abstract. This paper contains the descriptions of *Ostlingoceras* (*Ostlingoceras*) *bechei* (Sharpe, 1857), *O. (O.)* aff. *bechei*, and *Neostlingoceras carcitanense* (Matheron, 1842), all from the lower Cenomanian of the Mikasa and Kotanbetsu areas; also those of two new species *Neostlingoceras asiaticum* and *N. cobbani* from the middle Cenomanian of the Mikasa area. A new genus *Hypostlingoceras* is established, with descriptions of two new species, *H. japonicum* (type species) and *H. mikasaense*, from the lower Cenomanian of the same area.

Key words: *Carthaginites*, Cenomanian, *Hypostlingoceras*, *Neostlingoceras*, *Ostlingoceras*, Turrilitidae

Introduction

Recently ten species of *Mariella* and a few species of *Mesoturrilites*, *Hypoturrilites* and *Pseudhelicoceras* from the Cretaceous of Hokkaido have been described (Matsumoto *et al.*, 1999; Matsumoto and Kawashita, 1999; Matsumoto and Kijima, 2000; Matsumoto and Inoma, 1999; Matsumoto *et al.*, 2000). Sources of the material for these investigations are collections from the upper Albian and lower Cenomanian of the Soeushinai area of northwestern Hokkaido and the Shuparo and Hobetsu areas of central Hokkaido.

In this and succeeding papers additional species of the Turrilitidae are to be described. The material for this paper depends mainly on the collections from the celebrated Ikushunbetsu Valley of the Mikasa area. For a general account of the stratigraphy and the locality data readers may refer to Matsumoto (1991, p. 3–5; 21–24). Supplementary notes may be added to the particular cases concerned.

The purpose of our series of papers is to present precisely the systematic descriptions of the turrilitid ammonoids from the Cretaceous Yezo Group of Hokkaido, with confirmation or revision of previously known species and also establishment of new taxa. The described species could be useful for biostratigraphic subdivision and interregional correlation. As the faunal characteristics of the subdivided units of the Albian and the Cenomanian in the North Pacific region become clearer, the results could improve the knowledge of its palaeogeography and palaeoenvironments.

Repository.—The specimens described in this paper are to be stored in the Kyushu University Museum, Fukuoka, 812-8581, Japan, which is indicated by the letters GK at the head of a register number. To each specimen collected by T. T. a personal number was provisionally given. This numbering was set in accordance with the date of his field work. Although not official register numbers, they should not be ignored, because they are written clearly in red ink on each specimen and because they are tied to his field notes and will enable readers to get useful information. In this paper such numbers are indicated in brackets, as for instance, GK. H8531 [= previous S. 37·7·17] (Figure 1 D–F). Herein S. means *Showa*, a reign style in Japan and S. 37 = 1962.

A few specimens which were housed in the Geological Collections, Faculty of Culture and Education, Saga University, Saga, 840-8502, Japan (abbreviated as GS), are transferred to GK.

Systematic descriptions

Order Ammonoidea Zittel, 1884
Suborder Ancyloceratina Wiedmann, 1966
Superfamily Turrilitaceae Gill, 1871
Family Turrilitidae Gill, 1871
Genus *Ostlingoceras* Hyatt, 1900
Subgenus *Ostlingoceras* (*Ostlingoceras*) Hyatt, 1900

Type species.—*Turrilites puzosianus* d'Orbigny, 1842 (p. 587, pl. 143, figs. 1, 2) by original designation (Hyatt, 1900,

p. 587).

Diagnosis.—See Wright and Kennedy, 1996, p. 320.

Remarks.—Wright and Kennedy (1996, p. 320) treated *Parostlingoceras* Breistroffer (1953, p. 1350) as a subgenus of *Ostlingoceras*. No example of *O. (Parostlingoceras)* has been found in Hokkaido. In addition to *O. (O.) puzosianum* ten species were assigned to *O. (Ostlingoceras)* by Wright and Kennedy (1996, p. 321). Moreover, *Turrilites* cf. *colcanapi* of Pervinquier (1910, p. 50, pl. 14, fig. 4) from Algeria was revised to *O. (O.) collignoni* Wright and Kennedy (1996, p. 340, text-fig. 138E), although it deviates from the normal species of *O. (Ostlingoceras)* in its larger apical angle.

The available material of *O. (Ostlingoceras)* from Hokkaido is not numerous but fairly good in showing the characters that enable us to define more clearly previously named species. There are a few other indefinite taxa which are temporarily placed in this subgenus. One of them is described in this paper.

***Ostlingoceras (Ostlingoceras) bechei* (Sharpe, 1857)**

Figures 1A–C, D–F; 2A, B

Turrilites bechei Sharpe, 1857, p. 66, pl. 26, fig. 13 [as *bechii* on p.

66]

Ostlingoceras bechei (Sharpe, 1857). Wright and Wright, 1951, p. 18; Marcinowski, 1970, p. 435, pl. 3, fig. 5; Kennedy, 1971, p. 25 (*pars*), pl. 8, figs. 9, 13.

Ostlingoceras (Ostlingoceras) bechii (Sharpe, 1857). Atabekian, 1985, p. 50, pl. 14, fig. 6.

Ostlingoceras (Ostlingoceras) bechei (Sharpe, 1857). Wright and Kennedy, 1996, p. 321, pl. 96, figs. 6, 14–16, 18, 23.

Name of the species.—Two names have been used for this single species since Sharpe's (1857) original paper: *Turrilites Bechii* in the heading of the description (p. 66) and *Turrilites Bechei* in the explanation to plate 26, fig. 13a, b. Sharpe noted that the specimen was found by Sir H. T. de la Beche, and that it was named in his memory. We agree with Wright and Wright (1951, p. 18) in regarding *T. Bechii* as an obvious misprint for *T. Bechei*.

Holotype.—By monotypy, BMNH 88, the original of Sharpe, 1857, pl. 26, fig. 13, from the 'Cenomanian Limestone' near Lyme Regis, Devon (southern England).

Material.—GK.H8529 (Figure 1A, B, C), found by Tamotsu Omori near Loc. Ik1065b of the Shimo-ichino-sawa, a tributary of the River Ikushunbetsu; GK. H1381 (not figured), obtained in 1955 by T. M. at Loc. Ik1065b; GK.H8531 [previous

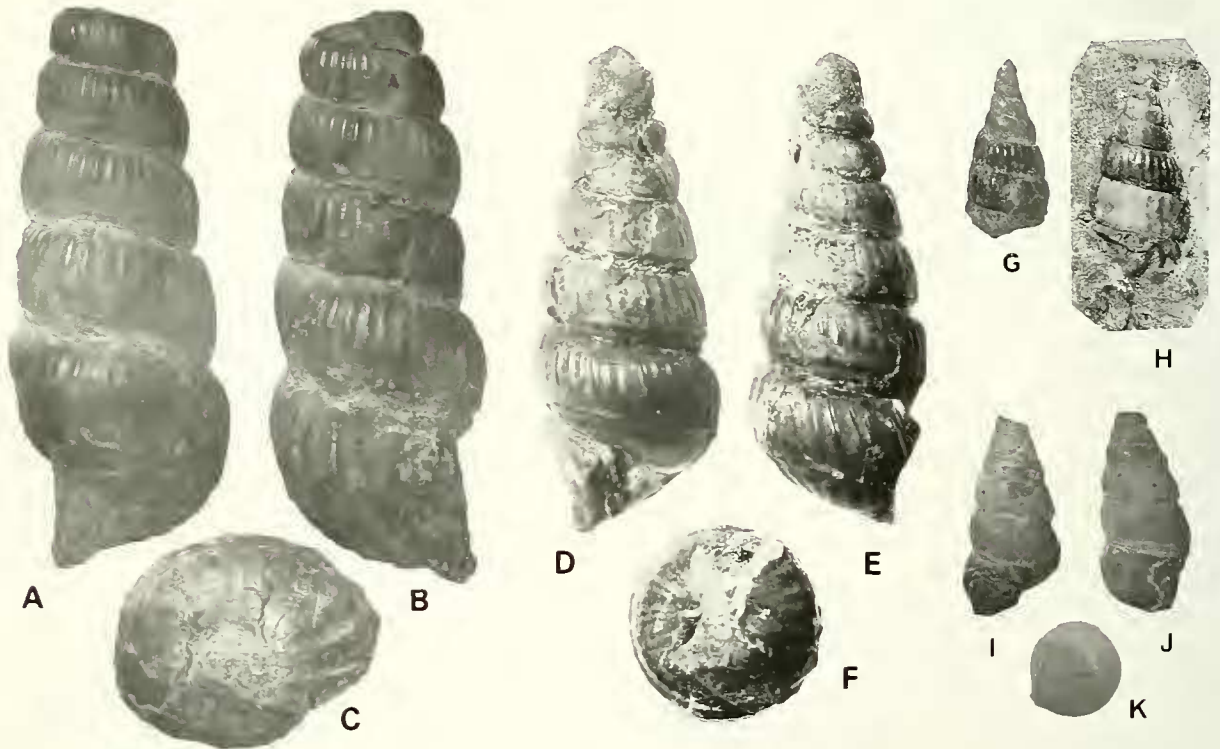


Figure 1. A–C, D–F. *Ostlingoceras (Ostlingoceras) bechei* (Sharpe, 1857). Two lateral (A and B, 180° apart) and basal (C) views of GK.H8529; similar views (D, E, F) of GK. H8531. G–H, I–K. *Ostlingoceras* aff. *bechei* (Sharpe, 1857). Extracted (G) and undeveloped (H) states of GK. H8530; two lateral (I, J) and basal (K) views of GK. H8555. All figures are $\times 2$, except for H ($\times 2.5$). Photos courtesy of M. Noda (D–F, H) and T. Nishida (others).

Table 1. Measurements of *Ostlingoceras* (*O.*) *bechei* (Sharpe).

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R	r/h
GK. H8529	5	38.0	58.0	17.5	20°	7.4	13.8	0.54	32	6–7
GK. H8531	5	27.0	40.0	12.5	23°	6.1	11.5	0.53	30	6
BMNH88	4	50.0	75.0	29.8	20°	11.5	21.5	0.53	—	7

NW = number of the preserved whorls, Hp = total height of the preserved whorls, Ht = total shell height from the preserved last whorl to the estimated apex, D = diameter of the preserved last whorl, ap = estimated apical angle, h = height of an exposed outer face [= flank] of a late whorl, d = diameter of the same whorl, R = number of ribs on the same whorl, r/h = number of ribs in the interval equal to h. Linear dimension is in mm.

S. 37·7·17] (Figure 1D, E, F), collected by T. T. in 1962 at a locality on the Onkonosawa, a branch of the River Ponbetsu, which is a major tributary of the River Ikushunbetsu.

Description.—The two illustrated specimens preserve five whorls but are dissimilar in size. Their dimensions are shown in Table 1. As the youngest part is lacking, the apical angle is estimated from the preserved part. It is fairly low but seems to vary to some extent between individuals (20°–23°).

The shell is turreted, sinistral, and the whorls are tightly in contact. The outer exposed whorl face is rounded, and its main part (= flank) is gently inflated and has a weak shoulder on its upper margin. Transverse ribs are numerous, somewhat prorsiradate, and moderately distinct. They are much weakened at (or interrupted by) a shallowly concave, narrow spiral zone in the lower part of the flank. They may be faintly swollen above this zone, showing sinuous curvature. Still lower, parallel to the lower whorl seam, there are two rows of spirally elongated tubercles, that correspond in number to the transverse ribs. The two rows tend to form narrow ridges, with an intervening, narrow groove between them. The lower ridge runs along the lower whorl seam. In other words it forms the outer outline of the basal surface, where the ribs extend to run with an anteriorly convex curvature to the narrow umbilicus. On the marginal part of the basal surface close to the second row of clavate tubercles there is another (i. e., fourth) row of small tubercles resting on the basal ribs.

The number of ribs seems to vary to some extent with growth and also between individuals. Where the shelly

layer is preserved the ribs are more distinct than on the internal mould.

In the preserved last part of GK. H8529, the largest specimen of the three, a few ribs tend to strengthen and curve more markedly than the other ones (Figure 1B, C). This could be inferred as flaring near the peristome, although the interpretation is uncertain.

Septal sutures are exposed on some parts of the flank, showing a fairly broad E–L saddle, L, and a narrower L–U saddle. These elements show minor incisions (Figure 2).

Comparison.—The specimens from Hokkaido are essentially similar to the holotype and other specimens from the 'Lower Chalk'. GK.H8529 surprisingly resembles the partly restored illustration of the holotype (Sharpe, 1857, pl. 26, fig. 13). Actually the holotype was in part enclosed by rock matrix, when one of us (T. M.) examined it at the Natural History Museum, London. Its characters are, however, well expressed by Sharpe's figure. The differences from the two illustrated specimens from Hokkaido are in the somewhat larger size and more delicate ribbing of the holotype. As the shelly layer is not preserved in the British specimen and as the number of ribs tend to increase with growth, the above differences are quite natural and would not invalidate the identification.

Discussion.—As described above, GK. H8529 may be almost adult, whereas the holotype, despite its larger shell, does not show the feature that should occur near the adult apertural end. This may suggest a difference in size. Wright and Kennedy (1996) pointed out the presence of size dimorphs in many species of the Turrititidae, although they did not discuss this problem with respect to *O. (O.) bechei*.

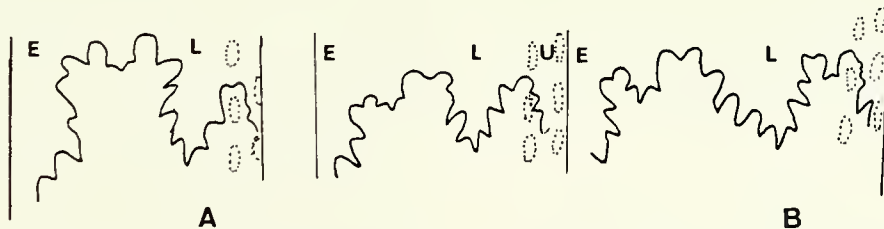


Figure 2. A, B. *Ostlingoceras bechei* (Sharpe, 1857). A: External suture on the-whorl flank of GK. H8531 at h = 4.5 mm. Figure is about $\times 7.5$. B: Ditto on the flank of successive whorls of GK. H8529 at h = 4.5 mm and 6.0 mm. Figure is about $\times 7$. Straight line: whorl seam, dotted line: tubercles; E: external lobe; L: lateral lobe; U: umbilical lobe. Drawing by T. M.

Table 2. Measurements of *Ostlingoceras* (*O.*) aff. *bechei* (Sharpe).

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R	r/h
GK. H8530	6	12.0	13.3	5.5	30°	2.2	5.0	0.44	25	4-5
GK. H8537	5	13.3	16.5	6.2	30°	3.0	6.2	0.48	27	5

Legend as for Table 1.

In fact, the available specimens are not numerous enough to determine whether the size difference mentioned above is an indication of individual variation or implies dimorphism. The question is left for further investigation.

Occurrence.—As for material. On the basis of the location, lithology and associated species, the described three specimens came from the lower part of the Member IIb of the Mikasa Formation and are of early Cenomanian age.

Distribution.—*Ostlingoceras* (*O.*) *bechei* has been reported to occur in the lower Cenomanian of England, Poland and Azerbaijan (see Wright and Kennedy, 1996, p. 322). Its occurrence in Hokkaido of the North Pacific region suggests a more extensive distribution of this species.

***Ostlingoceras* (*Ostlingoceras*) aff. *bechei* (Sharpe, 1857)**

Figure 1G, H; I-K

Material.—Two small specimens: GK.H8530 (Figure 1G, H) collected by T. M. at Loc. Ik1065b of the Shimo-ichino-sawa, a tributary of the River Ikkushunbetsu; GK. H8555 [= previous GS.G058] (Figure 1I, J, K) collected by Tamio Nishida and T. M. at Loc. R735 pl in the upper reaches of the River Oku-futamata, a branch of the River Kotanbetsu (see Nishida *et al.*, 1993, fig. 1 for the location). The second specimen is probably derived from the upper part of the lower Cenomanian on the basis of its location and associated *Inoceramus* cf. *virgatus* Schlüter.

Description.—These two specimens are generally similar to the typical specimens of *Ostlingoceras* (*O.*) *bechei* (Sharpe, 1857) described above, but the young part, at the same size as the former, is lacking or poorly preserved in the latter. As is shown in Table 2, the estimated apical angle is somewhat larger and the ribs are less numerous and seem to be relatively coarser and shorter in the former in comparison with the latter. Moreover, the preserved earliest whorl (diameter = 1.3 mm in GK. H8530) shows an inflated flank. Tentatively, we call this taxon *Ostlingoceras* (*O.*) aff. *bechei* (Sharpe), although the above difference might imply a change with growth in *O.* (*O.*) *bechei*. It seems to resemble the taxon from Germany which was described under '*O.* (*O.*) aff. *bechei*' by Lehmann (1998, p. 37, without figure), but as we have not examined the actual specimen, we hesitate to confirm the identity.

Genus ***Neostlingoceras*** Klinger and Kennedy, 1978

Type species.—*Turrillites carcitanensis* Matheron, 1842 (p. 267, pl. 41, fig. 4) by original designation (Klinger and Kennedy, 1978, p. 14).

Diagnosis.—Sinistrally coiled turrilicone, with low apical angle (less than 20°) and roughly flat flank of the whorl; or-

namented by coarse tubercles in an upper row and more numerous finer tubercles in lower 2 or 3 approximated or coalesced rows, with a shallowly concave zone below the upper row; faint transverse riblets may extend upward and/or downward and scarcely cross the concave belt. Siphuncle runs along the upper shoulder or still higher immediately below or along the upper whorl seam, depending on the species.

Discussion.—The type species and its allied species *N. oberlini* (Dubourdieu, 1953) have been regarded as being well defined. The available specimens are, however, mostly fragmentary, without showing the details of the early growth stage or those of the last stage. The origin of this genus has been sought in *Ostlingoceras* (Klinger and Kennedy, 1978, p. 15).

In addition to the above two species from the lower Cenomanian, Cobban and Hook (1981) and Cobban *et al.* (1989) described five species from the middle and upper Cenomanian of New Mexico, of which one species, *N. viridenense* Cobban, Hook and Kennedy, occurs also in the upper Cenomanian of England (Wright and Kennedy, 1996). Furthermore, there are two new species (described below) in the middle Cenomanian of Hokkaido. Some of these species are represented by very small specimens, as shown by *N. procerum* Cobban, Hook and Kennedy, 1989 (p. 60, figs. 62, 95, O, P) and *N. asiaticum* sp. nov. (to be established below). They are, in their early growth stage, very similar to *Carthaginites kerimensis* (Pervinquière, 1907) (p. 101, pl. 4, figs. 18, 19) or *C. krorzaensis* Dubourdieu, 1953 (p. 66, pl. 4, figs. 49–52). Hence, the question might arise that *Neostlingoceras* is a junior synonym of *Carthaginites*. Until the characters of the later growth stages in *Carthaginites* can be made clear, *Neostlingoceras* should be used in accordance with the current definition.

Occurrence.—The genus has been recorded to occur in the Cenomanian of France, England, Germany, Poland, Romania, Turkmenistan, Kazakhstan, Iran, Israel, Tunisia, Algeria, Madagascar, South Africa, New Mexico, Colorado, Wyoming, Texas and Japan. Although the type species and its allied species occur characteristically in the lower Cenomanian, other species are recorded from the middle and upper parts of the Cenomanian.

***Neostlingoceras carcitanense* (Matheron, 1842)**

Figure 3A–C, D–F

Turrillites carcitanensis Matheron, 1842, p. 261, pl. 41, fig. 4; Fabre, 1940, p. 242, pl. 5, fig. 7.

Turrillites morrisii Sharpe, 1857, p. 65 (*pars*), pl. 26, figs. 4, 6–7.

Hypoturrillites carcitanensis (Matheron). Kennedy, 1971, p. 59 (*pars*), pl. 6, figs. 1, 2, 4–6, 9, 10.

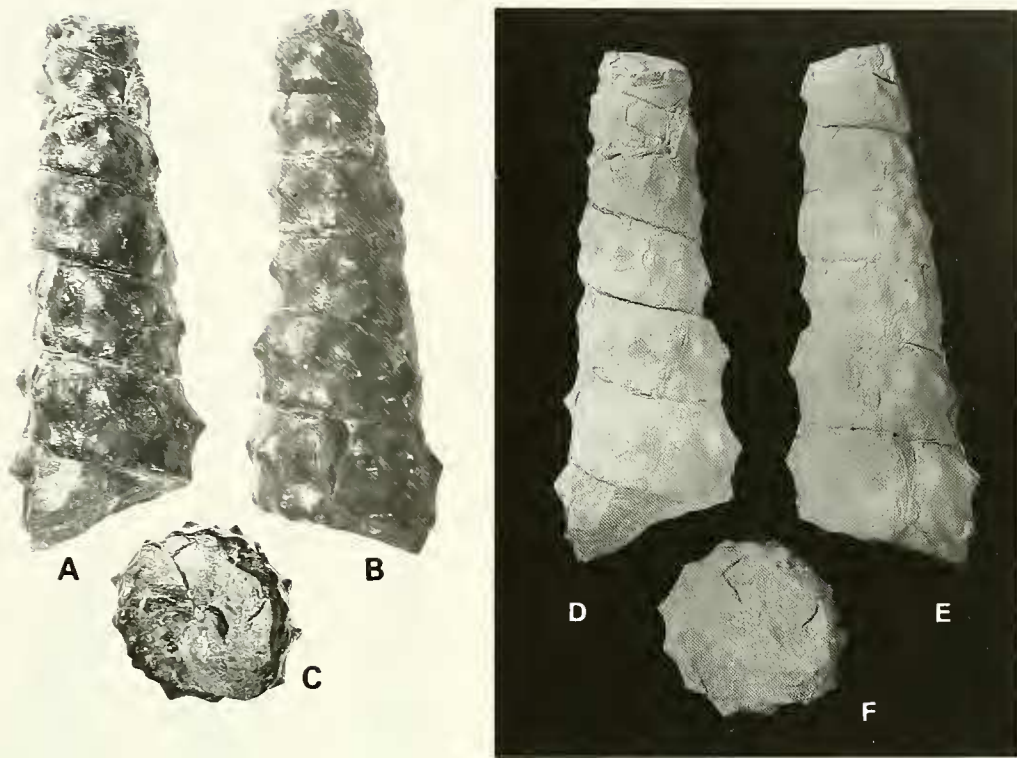


Figure 3. A–C, D–F. *Neostlingoceras carcitanense* (Matheron, 1842). Two lateral (A and B, 180° apart) and basal (C) views of GK. H8534, without whitening; similar views (D, E, F) of the same specimen with whitening. $\times 1$. Photos courtesy of M. Noda (A–C) and T. Nishida (D–F).

Turrilites (*Hypoturrilites*) *carcitanensis* (Matheron). Immel, 1979, p. 635, pl. 4, fig. 1.

Neostlingoceras carcitanense (Matheron). Klinger and Kennedy, 1978, p. 15 (*pars*), pl. 3, fig. G; Wright and Kennedy, 1996, p. 326, pl. 99, figs. 1–7, 9–15, 18, 19, 22; pl. 100, fig. 8; text-fig. 140B (with full synonymy).

Holotype.—By monotypy, the original of Matheron, 1842, pl. 41, fig. 4. We have not seen the specimen, which seems to be fragmentary as shown by Fabre's (1940, pl. 5, fig. 7) reillustration. The type locality is in southern France. Its present repository is uncertain (see Wright and Kennedy, 1996, p. 327).

Material.—GK. H8534 [= previous S. 40·8·15] (Figure 3A–C, D–F), collected by T. T. in 1965 at Loc. 1k1054 below the bridge called 'Katsura-Ohashi'. It was found in the dark green silty fine-grained sandstone of the Zone of *Mantelliceras japonicum*. Another crushed specimen, GK. H8556, was found by T. M. at Loc. R82 of the Soeushinai-Kontanbetsu area (for the location see Matsumoto and Okada, 1973, fig. 7). It was from the mudstone in the lower part of the Member My5. One of us (T. M.) examined the specimens from England (see above synonymy) at the Natural History Museum, London to compare them with ours.

Description.—Six continuous whorls are preserved in GK. H8534, which is 47 mm high altogether and 15.6 mm in diameter of the last whorl. The ratio of height to diameter in the exposed part of each whorl is roughly 5:9. The apical angle estimated from the preserved part of the shell is as low as 13°. The early part of the shell is lacking.

Each whorl is ornamented by an upper row of larger tubercles, 13 to a whorl, and a lower row of smaller, double tubercles 18 or 19 per whorl, above the lower whorl seam. The upper tubercle is pointed at the top and its base is bullate upward, whereas a concave spiral zone runs at about the

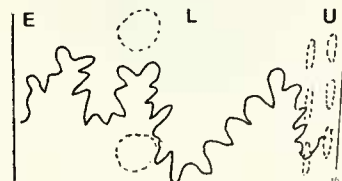


Figure 4. *Neostlingoceras carcitanense* (Matheron, 1842). External suture of GK. H8534 on the flank at $h = 7.8$ mm. Figure is about $\times 5.5$. Symbols as for Figure 2. Drawing by T. M.

midflank immediately below the row of major tubercles. The double tubercle of the lower row consists of a small subrounded upper one and rather clavate lower one which are closely set. Some of the upper ones are bullate upward, whereas the lower ones form the outer edge of the basal surface.

The suture is exposed on a part of the flank, showing L in the middle part of the flank, with saddles on either side of L. They are moderately incised at the middle growth stage (Figure 4).

Remarks.—When the genus *Neostlingoceras* was introduced, Klinger and Kennedy (1978, p. 15) considered that *N. carcitanense* (Matheron, 1842) is so variable that *N. oberlini* (Dubordieu, 1953) and some others were within its variation or might be subspecies in a successive sequence. Such an interpretation has been recently denied by Wright and Kennedy (1996, p. 327–328), with whom we agree.

Comparison.—The described specimen shows clearly the morphological characters of this species. It quite well resembles a specimen called SAS SM (Klinger and Kennedy, 1978, pl. 3, fig. G) from the Mzinene Formation, Cenomanian II, of the Skoenburg, Zululand.

Occurrence.—As for material. This species marks the basal zone of the Cenomanian in England, but it occurs in the beds of the next and still higher levels in Hokkaido.

***Neostlingoceras asiaticum* sp. nov.**

Figures 5 A–C, D–F, G–I; 6

Material.—Holotype is GK. H8536 [= previous S. 36·8·26] (Figure 5A, B, C) collected by T. T. in 1961 at Loc. Ik1103 from the middle part of the Cenomanian in the Mikasa area on the western wing of the Ikushunbetsu anticline. Two other specimens (paratypes) are GK. H8537 [= previous S.

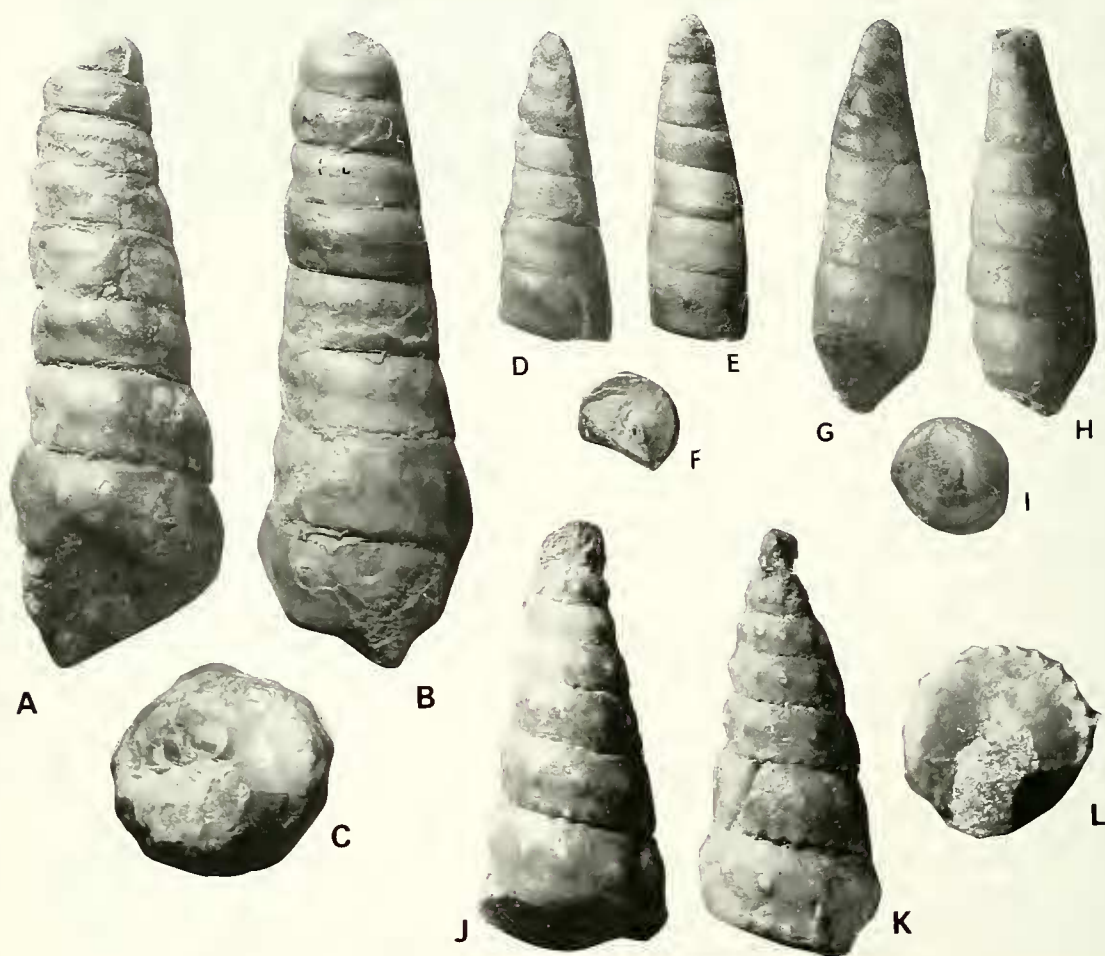


Figure 5. A–C, D–F, G–I. *Neostlingoceras asiaticum*, sp. nov. Two lateral (A and B, 180° apart) and basal (C) views of GK. H8536 (holotype). Similar views (D, E, F) of GK. H8537 and ditto (G, H, I) of GK. H8538. J–L. *Neostlingoceras cobbani* sp. nov. Two lateral (J and K, 180° apart) and basal (L) views of GK. H8535 (holotype). Figures are all $\times 3$. Photos courtesy of M. Noda.

Table 3. Measurements of *Neostlingoceras asiaticum* sp. nov.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	T	t
GK. H8536	7.5	28.0	45.3	10.0	13°	3.8	8.7	0.44	15	30
GK. H8537	6 + a	14.2	21.0	4.7	14°	2.2	4.7	0.47	—	—
GK. H8538	7	16.2	26.0	5.3	15°	2.5	5.5	0.48	16	32

T = number of upper tubercles, t = number of lower tubercles, 6 + a = somewhat over 6. See Table 1 for other abbreviations.

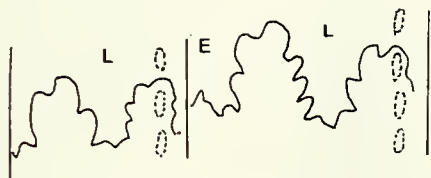


Figure 6. *Neostlingoceras asiaticum* sp. nov. External suture on the flank of two successive young whorls of GK. H8537 at $h = 1.4$ mm and 1.9 mm. Figure is about $\times 16$. Symbols as for Figure 2. Drawing by T. M.

55·3·10A] (Figure 5D, E, F) and GK. H3538 [= S. 55·3·10B] (Figure 5G, H, I) collected by T. T. in 1980 at the type locality (Ik1103). This locality belongs to the Abundance Zone of *Calycoceras* (*Newboldiceras*) *asiaticum*.

Diagnosis.—Shell slender with a low apical angle; whorl at early growth stage rather flat-sided, with rounded upper shoulder and shallow groove at midflank. Later, blunt nodes are developed on the upper shoulder and numerous minute tubercles are aligned along the lower edge of the flank. Suture fundamentally similar to that of *Ostlingoceras* (*O.*) *bechei*, but apparently simple on account of the small size of the shell (Figure 6).

Description.—The three specimens are all small as shown in Table 3. They preserve the shell layer for the most part. In GK.H3537, the smallest specimen, the suture is well shown at its preserved middle stage (2.3 mm in whorl height). It is rather simple, but the elements (L and the saddles on either side) exposed on the next whorl show more clearly minor indentations. L is situated on the concave zone of the midflank.

The holotype is the largest of the three specimens. Its earlier part is lacking. If its preserved last part be assumed to reach a part of the last whorl, the restored outline of the shell would be roughly 45 mm in height.

In every specimen the whorl junction is clearly impressed. The ratio of height to diameter in each whorl is low (less than 0.5). A gradual change of ornament with growth is evidently shown by the holotype. Two paratypes generally follow the holotype in this regard.

In young whorls a shallow and narrow, spiral groove runs at about the midflank and a low, spiral elevation above the groove forms a rounded shoulder in the upper part of the flank.

In the next step of growth, the upper elevation is faintly undulated and the lower edge of the whorl has numerous, tiny tubercles. Soon this is followed by broadening of the upper

elevation on which bluntly raised and upward bullate nodes are developed. The spiral groove below the upper elevation is somewhat shifted downward from the midflank and numerous small tubercles become distinct on the lower edge. The upper tubercles are 15 or 16 per whorl and the lower ones are twice as numerous as the upper ones. Both tubercles become gradually distinct with growth and a short riblet extends upward from each of the lower tubercles. Finally on the preserved last whorl narrow transverse ribs run obliquely downward (i. e., adorally) from some of the upper tubercles. Underneath the row of lower tubercles there is a train of narrowly clavate tubercles, which defines the margin of the basal surface of the whorl.

Comparison.—This species is unique among the nine species of *Neostlingoceras* in that its younger part is similar to *Carthaginites krorzaensis* Dubourdieu, 1953 (p. 66, pl. 4, figs. 49–52, text-fig. 20), from the upper Cenomanian of eastern Algeria, also to *C. cf. krorzaensis*, from the upper Cenomanian of England (Wright and Kennedy, 1996, p. 361, pl. 98, fig. 11), whereas its later whorls show the general characters of *Neostlingoceras*.

The present species somewhat resembles *N. bayardense* Cobban, Hook and Kennedy, 1989 (p. 60, figs. 95R, 96R), from the Zone of *Calycoceras canitaurinum* in New Mexico, but the latter has a still lower apical angle (11°), distinctly flatter flank and finer and more numerous tubercles in the upper row.

N. procerum Cobban, Hook and Kennedy, 1989 (p. 60, figs. 62, 95 O–Q, S), from the upper Cenomanian *Metoicoceras mosbyense* Zone in New Mexico, is also similar to the younger part of the present species. Its shell is, however, more slender with a lower apical angle (10°). In later growth stages the nodes in the upper row are more distinct and coarser in *N. asiaticum*. It should be noted that transverse ribs occur at the late growth stage in both species.

Occurrence.—As for material. It should be noted that the present species is fairly close in geological age to *N. bayardense* mentioned above.

Neostlingoceras cobbani sp. nov.

Figure 5J–L

Material.—Holotype, designated herein, is GK. H8535 [= previous S.36·3·28] (Figure 5J, K, L), collected by T. T. in 1961 at loc. Ik1103 of Nishikatsurazawa, from the middle Cenomanian part of the Mikasa Formation on the western wing of the Ikushunbetsu anticline. At present it is the sole available material for this rare but noteworthy species.

Specific name.—In honor of William A. Cobban, who has

Table 4. Measurements of *Neostlingoceras cobbani* sp. nov.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	T	t
GK. H8535	6 + a	20.0	25.5	8.8	20°	3.5	7.5	0.47	10	25

Abbreviations as for Table 3.

made a remarkable contribution to palaeontology and biostratigraphy.

Diagnosis.—A species of *Neostlingoceras* that shows a comparatively less acute apical angle for the genus, distantly disposed and rather bluntly elevated tubercles of the upper row, shallower concave zone at midflank and numerous, small tubercles of the lower row. Small size of the shell appears to be diagnostic, but is not necessarily definite.

Description.—This specimen preserves six whorls, but its very apex and late whorls are unpreserved. It is small, as shown in Table 4, although the true size of the completely preserved original shell is not known. The proportion of height to diameter of each whorl is less than 0.5. The apical angle as estimated from the preserved part of the shell is 20°.

The upper part of the outer exposed whorl face slopes down to the upper row of tubercles where a shoulder is formed. The tubercles of this row are distant and not numerous; 10 per whorl on average. Each of them is a bluntly pointed node which is broadened but lowered upward. A shallowly concave spiral zone runs below the upper row of major tubercles. Minor tubercles of the lower row are numerous, 25 per whorl. They are arranged in a single row immediately above the lower whorl seam, but each of them seems to be double, as it is granular in lateral view but is rather clavate in lower view, forming the outer edge of the lower face of the whorl. In other words the lower tubercles may be those of united 2nd and 3rd rows. Sometimes faint riblets may extend upward from the lower tubercles across the concave zone below the row of major tubercles. On the lower face of the whorl ribs are scarcely discernible.

The suture is not well traced. The preserved last whorl is still septate, showing minor indentation on the lobes of L, U and adjacent saddles.

Comparison.—Although the specimen is small, it shows the generic characters of *Neostlingoceras*. It is distinguished from *N. carcitanense* by the diagnosis (see above). Although the ratio of height to diameter of each whorl may vary to some extent within a species, it is generally smaller in the present species than in the cases of *N. carcitanense*, *N. oberlini* and also *N. kottlowskii* Cobban and Hook, 1981 (p. 26, pl. 4, figs. 1–28; Cobban, 1984, p. 17, pl. 4, fig. 9; Cobban *et al.*, 1989, p. 60, fig. 95 A–F). *N. kottlowskii* is closer in geological age to the present species than the other two.

Occurrence and distribution.—As for material; unique at present.

Genus *Hypostlingoceras* nov.

Type species.—*Hypostlingoceras japonicum* sp. nov. (described below).

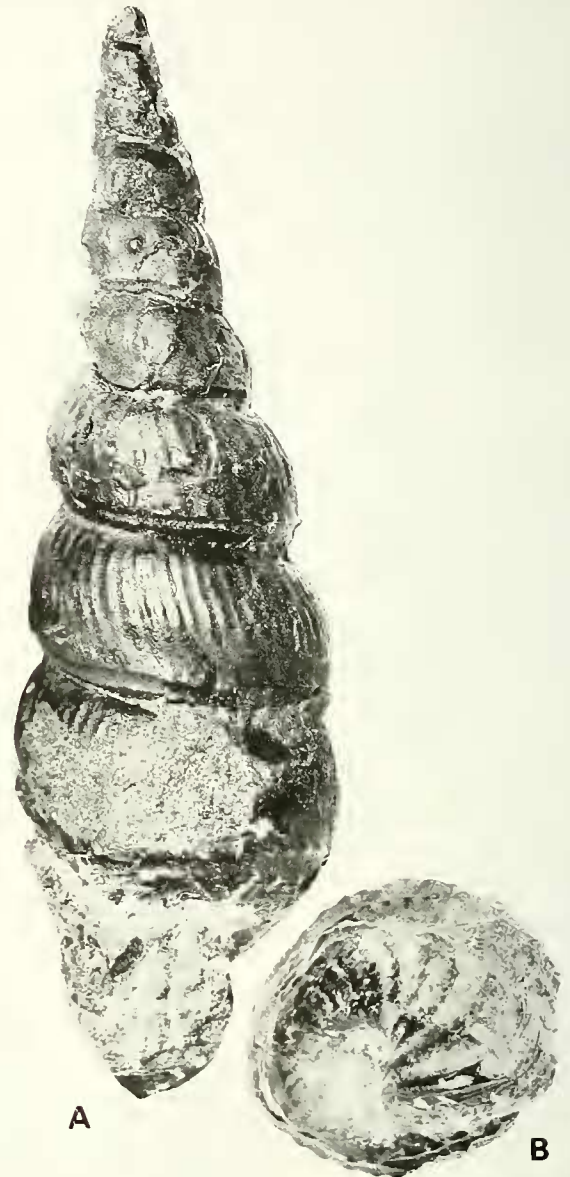


Figure 7. A, B. *Hypostlingoceras japonicum* gen. et. sp. nov. Lateral (A) and basal (B) views of GK.H8542 (holotype). Figures are $\times 2$. Photos courtesy of M. Noda.

Diagnosis.—Turrilitid ammonoids which show peculiar change of characters with growth. Whorls in early growth stages have coarse or strong tubercles at about the midflank and numerous, minute tubercles in at least two lower rows. Sooner or later the tubercles at midflank gradually weaken and become sparse, whereas transverse ribs intervene between the tubercles. Finally the midflank tubercles disappear, while numerous transverse ribs predominate, and thus the ornamentation as well as the whorl shape becomes quite similar to that of *Ostlingoceras*.

Discussion.—On account of its more or less slender shell shape and small size, this genus resembles *Neostlingoceras* rather than *Hypoturrilites* in its youth. In more or less later growth stages it is quite similar to *Ostlingoceras*. The stage at which the characters of the *Neostlingoceras* type change to those of the *Ostlingoceras* type varies to some extent, and the change occurs more or less gradually. Based on the above facts, we presume that *Hypostlingoceras* may have been derived from *Ostlingoceras* in parallel with *Neostlingoceras*. The type specimens are never artificial chimeras.

Occurrence.—At present this genus is represented by two species from the lower Cenomanian in the Mikasa area of Hokkaido. More material should be searched for to determine clearly the geological and geographical distribution as well as the phylogenetic relationships of this genus.

***Hypostlingoceras japonicum* sp. nov.**

Figures 7A, B; 8A–E; 9A–E; 10

Material.—Holotype, designated herein, is GK. H8542 [= previous S. 36·7·25] (Figures 7A, B; 8A, B, C, D, E), collected by T. T. in 1961 from the lower part of the Mikasa Formation exposed on the Ganseki-zawa, i. e., the eighth branch of the Kami-ichino-sawa, a tributary of the River Ikushunbetsu. Paratype is GK. H8541 [= previous S. 39·9·11] (Figure 9A, B, C, D, E) collected by T. T. in 1964 at Loc. 7045 of T. T. in the Suido-no-sawa, a short branch of the River Ikushunbetsu. The beds at the above two localities are referred to the *Mantelliceras japonicum* Zone, and are early Cenomanian in age.

Diagnosis.—Shell shape is slender, with low apical angle, and rather small. Whorls in youth subtrapezoid in lateral view, with square shoulder at midflank where coarse and strong tubercles are disposed at intervals. Then comes a transitional stage, where whorl is subrounded, midflank tubercles weaken and extend upward to ribs and additional intervening ribs occur. Whorls in later growth stages gently inflated on side and ornamented densely by numerous transverse ribs. Minute tubercles are aligned on the lower two narrow ridges throughout growth.

Description.—The two specimens, GK. H8542 and GK. H8541, are much different in size but similar in their slender

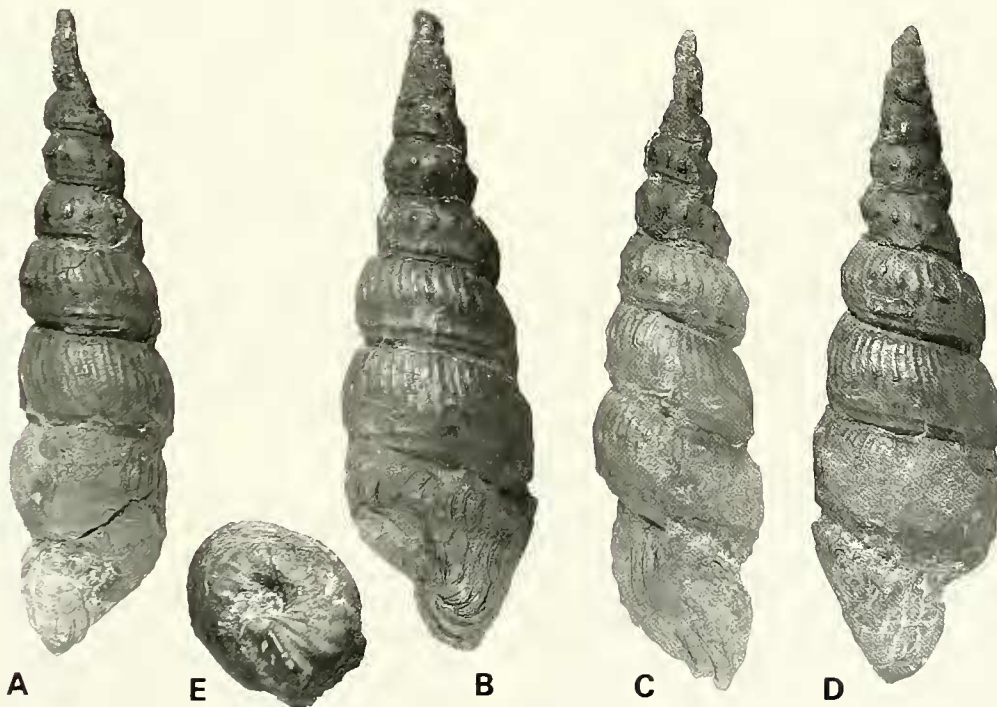


Figure 8. A–E. *Hypostlingoceras japonicum* gen et sp. nov. Four lateral (A, B, C, D, successively 90° apart clockwise) and basal (E) views of GK.H8542 (holotype). Figures are $\times 1.2$. Photos courtesy of T. Nishida.

Table 5. Measurements of *Hypostlingoceras japonicum* sp. nov.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R	T	t
GK. H8542	8 + a	69.0	80.0	20	18°	11.0	19.0	0.58	40	16	30
GK. H8541	7 + a	26.5	34.0	8.5	18°	4.2	7.4	0.57	32	15	—

Abbreviations as for Tables 1 and 4. T and t are measured on the whorl at 2 volutions earlier than that where h, d, and R are measured.

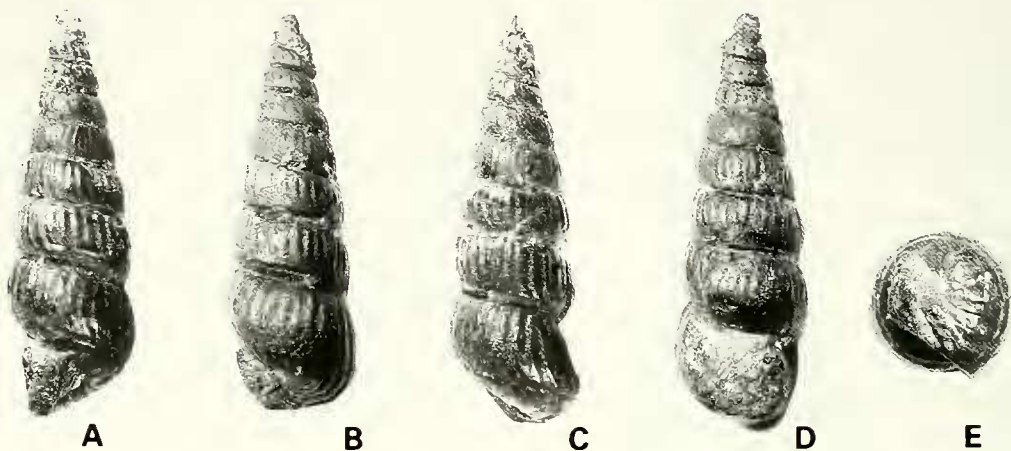


Figure 9. A–E. *Hypostlingoceras japonicum* gen. et sp. nov. Four lateral (A, B, C, D, successively 90° apart clockwise) and basal (E) views of GK.H8541 (paratype). Figures are $\times 2$. Photos courtesy of M. Noda.

shell shape with a low apical angle (about 18°) and the proportion of the flank height and diameter of each whorl is slightly above 0.5 (see Figures 7–9 and Table 5). The stage characterized by strong midlateral tubercles is manifested by several young whorls in the two specimens, although the youngest part is destroyed or unpreserved. The change in the whorl shape and ornamentation is evident in both specimens, but it occurs in the whorl at a diameter of about 15 mm in GK. H8542, whereas it occurs at a diameter of about 5 mm in GK. H8541. An *Ostlingoceras*-like late stage continues for fully 3 whorls in the smaller specimen (GK. H8541) and for 2.5 whorls in the larger one (GK. H8542).

In the larger specimen the longitudinal ribs become denser and more numerous on the whorl of the later growth stage (Figure 8). However, near the preserved last part a few ribs strengthen and markedly curve on the convex basal surface (Figure 7B). However, as the last whorl is partly destroyed, we cannot confirm the real peristome. In the smaller specimen the ribs do not become particularly dense and numerous in the preserved last whorl. They curve rather moderately on the convex lower surface (Figure 9).

Almost throughout growth, in both specimens, small tubercles are aligned in two rows on the narrowly raised ridges which are separated by a narrow groove. At first these minor tubercles correspond in number and disposition to the major ones, but soon they become more numerous and clavate. These two rows of minor tubercles correspond to

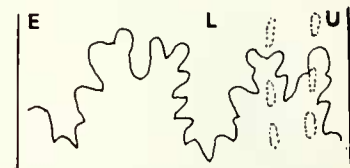


Figure 10. *Hypostlingoceras japonicum* gen. et sp. nov. External suture of GK. H8541 (paratype) on the preserved last whorl at $h = 5$ mm and $d = 8.2$ mm. Figure is about $\times 9$. Symbols as for Figure 2. Drawing by T. M.

the second and third rows in certain species of *Ostlingoceras* (*Ostlingoceras*). The second row forms the lower edge of the flank and the third row runs along the lower whorl seam.

In the early stages there is a concave spiral zone below the subangular zone of strong tubercles. In the transitional and later stages, the concave zone shifts downward and the ribs have more or less weakened smaller tubercles above this zone. These minor tubercles may be so reduced that they may be sometimes expressed as faint swellings. The ribs extend further to run across the concave zone with gentle sinuosity and weakening and are connected with minor tubercles of the second row. In addition to the tubercles of

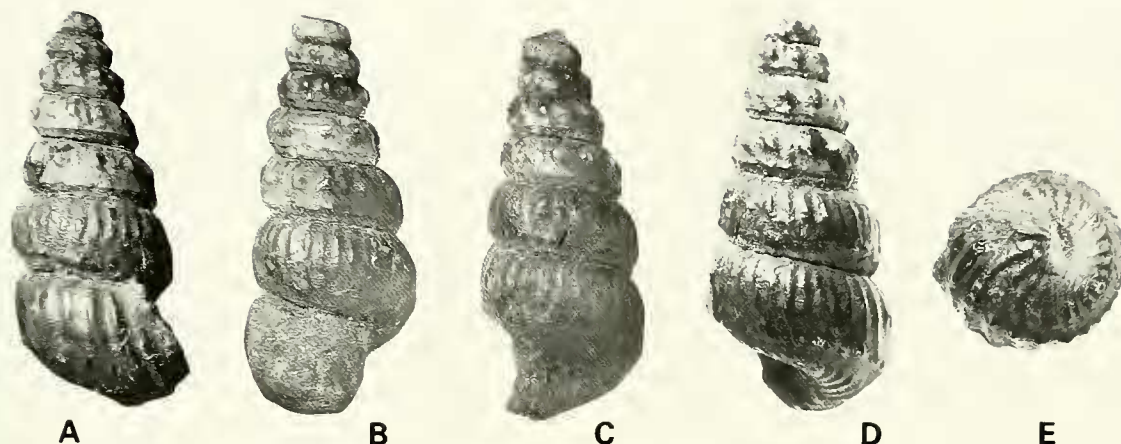


Figure 11. A-E. *Hypostlingoceras mikasaense* gen. et sp. nov. Four lateral (A, B, C, D, successively 90° apart clockwise) and basal (E) views of GK.H8540 (holotype). All figures are $\times 2.1$. Photos courtesy of T. Nishida (A-C) and M. Noda (D, E).

Table 6. Measurements of *Hypostlingoceras mikasaense* sp. nov.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R	T	t
GK. H8540	6	26.0	32.0	13.0	30°	4.6	10.3	0.45	30	14	23

Abbreviations as for Table 5.

the third row, those of the fourth row may be discernible on some ribs of the basal surface.

A septal suture is observed on the preserved last whorl of the smaller specimen (see Figure 10).

Discussion.—The specimen, OM.II-497, illustrated as '*Turrilites* cf. *costatus* Lamarck' by Ikegami and Omori (1957, pl. 14, fig. 3), from their Unit MK1 (= Member IIb of Matsumoto, 1965, fig. 4; 1991, p. 22-24), was listed under *Ostlingoceras* (*O.*) aff. *colcanapi* (Boule, Lemoine and Thévenin, 1907) by Wright and Kennedy (1996, p. 323). Its figure shows, however, a more slender shell shape with a lower apical angle and its younger whorls have a row of coarse tubercles at about midflank. It is probably another example of this species. Regrettably, the original specimen is missing at present.

Occurrence.—As for material.

Hypostlingoceras mikasaense sp. nov.

Figure 11A-E

Material.—Holotype is GK. H8540 [= previous S. 51·7·4] (Figure 11A, B, C, D, E), collected by T. T. in 1976 at a locality on the northeastern rivulet ['Migimata'] of the Ganseki-zawa, i. e., the eighth branch of the Kami-ichi-no-sawa, a tributary of the River Ikushunbetsu. The exposed rock of the type locality is referred to the *Mantelliceras japonicum* Zone of the Mikasa Formation.

Diagnosis.—Shell small, with a moderate apical angle, about 30° as estimated from the preserved part. Whorls in

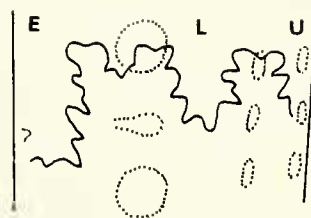


Figure 12. *Hypostlingoceras mikasaense* gen et sp. nov. External suture of a young stage at $h = 4.2$ mm. Figure si about $\times 9.5$. Symbols as for Figure 2. Drawing by T. M.

youth subtrapezoid in lateral view with shoulder at about the midflank, where coarse and strong tubercles are aligned. Change of ornament at transitional growth stage generally follows that of the type species. Later whorls show moderately to gently convex flanks and ornamentation like that of *Ostlingoceras* (*O.*) *bechei* (Sharpe, 1857).

Description.—The holotype consists of about 6 whorls, but its apical part is lacking. The preserved part of the shell is 26 mm high and its diameter at the last whorl is 13 mm. The apical angle estimated from the preserved part of the shell is about 30°. Whorls are tightly in contact, with a fairly deeply impressed junction. The ratio between flank height and diameter in each whorl is about 0.45 (see Table 6).

The shape of a young whorl in lateral view is trapezoid, with an angular shoulder at about the midflank, where strong tubercles are aligned at moderate intervals, numbering 12 per whorl. Another row of smaller tubercles runs on a narrow ridge slightly above the lower whorl seam. On the preserved first whorl these lower tubercles are fairly coarse and correspond in number and disposition to the upper tubercles. Soon the upper strong tubercles are bullate and the lower tubercles become finer and tend to be clavate.

In the transitional stages the upper tubercles are weakened, transversally elongated and distantly arranged, whereas a few nodeless ribs occur in the intervening space. The minor tubercles on the lower spiral ridge are disposed approximately on the extension of the elongated tubercles and intervening ribs. Throughout the above-described stages there is another row of clavate tubercles along the lower whorl seam. There is a narrow but distinct spiral groove between the two lower rows of minor tubercles.

In the late stages, including the late transitional substage, the whorl develops a more rounded shape, showing a gently convex flank. It is ornamented by numerous transverse ribs, numbering 32 in the preserved last whorl. Above the second row of minor tubercles there is a shallowly concave spiral zone. The ribs run across this concave zone with slight weakening and sinuosity. In the preserved last whorl the third row of minor tubercles is not clavate but elevated at the markedly curved point of the ribs on the marginal part of the basal surface. Some of the tubercles seem to be doubled, suggesting incorporation of the remnants of the tubercles of the fourth row (Figure 11E). The ribs extend further toward the narrow umbilicus with a gentle curvature.

The septal suture is partly exposed on the flank of a rather young whorl, showing half of E, the E-L saddle, entire L and a part of the L-U saddle. L is situated on the concave zone below the upper row of the tubercles. These elements are indented (Figure 12).

Comparison.—With respect to the general change of characters with growth, this species is assigned to the genus *Hypostlingoceras*. It is distinguished from *H. japonicum* in having a larger apical angle, smaller ratio of h/d in each whorl, stronger midflank tubercles in youth and somewhat coarser and less numerous ribs on the later whorls.

The whorls of this species in late growth stages are fairly similar to *Ostlingoceras* (*Ostlingoceras*) *bechei* (Sharpe) in shell shape and ornamentation, although this does not necessarily imply a direct phylogenetic relationship.

Occurrence and distribution.—As for material. At present this species is known solitarily in the lower part of the Cenomanian of Hokkaido.

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References

- Atabekian, A. A., 1985: Turritulids of the late Albian and Cenomanian of the southern part of the USSR. *Academy of Sciences of the USSR, Ministry of Geology of the USSR, Transactions*, vol. 14, p. 1–112, pls. 1–34. (in Russian)
- Boule, M., Lemoine, P. and Thévenin, A., 1907: Céphalopodes crétacés des environs de Diégo Suarez. *Annales de Paléontologie*, vol. 2, p. 1–58, pls. 1–8.
- Breistroffer, M., 1953: L'évolution des Turritulites albiens et cenomaniens. *Compte Rendus Hebdomadaires des Sciences de l'Académie des Sciences*, vol. 237, p. 1349–1351.
- Cobban, W. A., 1984: Molluscan record from a mid-Cretaceous borehole in Western County, Wyoming. *U. S. Geological Survey, Professional Paper*, no. 1271, p. 1–24.
- Cobban, W. A. and Hook, S. C., 1981: New turritulid ammonite from the mid-Cretaceous (Cenomanian) of southwestern New Mexico. *New Mexico Bureau of Mines and Mineral Resources, Circular* 180, p. 22–29.
- Cobban, W. S., Hook, S. C., and Kennedy, W. J., 1989: Upper Cretaceous rocks and ammonite faunas of southwestern New Mexico. *New Mexico Bureau of Mines and Mineral Resources, Memoir* 45, p. 1–137.
- Dubourdieu, G., 1953: Ammonites nouvelles des Monts du Mellègue. *Bulletin du Service de la Carte Géologique de l'Algérie. 1re Série, Paléontologie*, no. 16, p. 1–76, pls. 1–4.
- Fabre, S., 1940: Le Crétacé supérieur de la Basse-Provence occidentale. 1. Cenomanien et Turonien. *Annales de la Faculté de Sciences de Marseille, série 2*, vol. 14, pl. 1–355, pls. 1–10.
- Gill, T., 1871: Arrangements of the families of Mollusks. *Smithsonian Miscellaneous Collections*, no. 227, p. i–xvi, 1–49.
- Hyatt, A., 1900: Cephalopoda, In, Zittel, K. A.: *Text book of Palaeontology*, 1st English edition translated by C. R. Eastman, p. 502–592. Macmillan, London and New York.
- Ikegami, S. and Omori, T., 1957: On the so-called "Mikasa Formation" in the Katsurazawa-dam site area near the Ikushunbetsu River, Mikasa, Hokkaido. *Journal of the Hokkaido Gakuhei University, ser. 2*, vol. 8, no. 1, p. 70–89, pls. 1–14. (in Japanese with English explanation of plates)
- Immel, H., 1989: Cenoman-Ammoniten aus den Losensteiner Schichten der Bayerischen Alpen. In, Wiedmann, J., ed., *Aspekte der Kreide Europas. International Union of Geological Sciences, ser. A*, no. 6, p. 607–644, pls. 1–4. Schweizerbartische Verlagsbuchhandlung, Stuttgart.
- Kennedy, W. J., 1971: Cenomanian ammonites from southern England. *Special Papers in Palaeontology*, vol. 8, p. 1–133, pls. 1–64.
- Klinger, H. C. and Kennedy, W. J., 1978: Turritulidae (Cretaceous Ammonoidea) from South Africa, with a discussion of the evolution and limits of the family. *Journal of Molluscan Studies*, vol. 44, p. 1–48, pls. 1–9.
- Lehmann, J., 1988: Systematic palaeontology of the ammonites of the Cenomanian-Lower Turonian (Upper Cretaceous) of northwestern Westphalia, north Germany. *Tübinger Geowissenschaftliche Arbeiten, Reihe A*, vol.

- 37, p. 1-58, pls. 1-5.
- Marcinowski, R., 1970: The Cretaceous transgressive deposits east of Czystochowa (Polish Jura Chain). *Acta Geologica Polonica*, vol. 20, p. 413-449, pls. 1-6.
- Matheron, P., 1842: *Catalogue méthodique et descriptif des corps organisés fossiles du Département des Bouches-du-Rhône et lieux circonvoisins*, 269 p., 41 pls. Marseille.
- Matsumoto, T., 1965: A monograph of the Collignoniceratidae from Hokkaido. Part 1. *Memoirs of the Faculty of Science, Kyushu University, ser. D*, vol. 16, no. 1, p. 1-80, pls. 1-18.
- Matsumoto, T. (compiled), 1991: The mid-Cretaceous ammonites of the family Kossmaticeratidae from Japan. *Palaeontological Society of Japan, Special Papers*, no. 33, p. i-vi, 1-143, pls. 1-31.
- Matsumoto, T. and Inoma, A., 1999: The first record of *Mesoturritites* (Ammonoidea) from Hokkaido. *Paleontological Research*, vol. 3, no. 1, p. 36-40.
- Matsumoto, T., Inoma, A. and Kawashita, Y., 1999: The turrilitid ammonoid *Mariella* from Hokkaido-Part 1. *Paleontological Research*, vol. 3, no. 2, p. 106-120.
- Matsumoto, T. and Kawashita, Y., 1999: The turrilitid ammonoid *Mariella* from Hokkaido-Part 2. *Paleontological Research*, vol. 3, no. 3, p. 162-172.
- Matsumoto, T. and Kijima, T., 2000: The turrilitid ammonoid *Mariella* from Hokkaido-Part 3. *Paleontological Research*, vol. 4, no. 1, p. 33-38.
- Matsumoto, T. and Okada, H., 1973: Saku Formation of the Yezo geosyncline. *Science Reports of the Department of Geology, Kyushu University*, vol. 11, no. 2, p. 275-309. (in Japanese with English abstract)
- Matsumoto, T., Takashima, R. and Hasegawa, K., 2000: Some turrilitid ammonites from the Cretaceous of the Shuparo Valley, central Hokkaido. *Bulletin of the Mikasa City Museum, Natural Science*, no. 4, p. 1-13.
- Nishida, T., Matsumoto, T., Yao, A. and Malya, S., 1993: Towards the integrated mega- and micro- biostratigraphy on the Cenomanian (Cretaceous) sequence in the Kotanbetsu Valley, Hokkaido, including the C-T boundary problem. *Journal of the Faculty of Education, Saga University*, vol. 40, no. 3, p. 95-125. (in Japanese with English abstract)
- Orbigny, A. d', 1842: *Paléontologie française. Terrains crétacés. 1. Céphalopodes*, p. 431-662. Masson, Paris.
- Pervinquière, L., 1907: *Études de paléontologie tunisienne. 1. Céphalopodes des terrains secondaires. Carte Géologique de la Tunisie*, 438p., atlas (27 pls.). Rudeval, Paris.
- Pervinquière, L., 1910: Sur quelques ammonites du Crétacé algérien. *Mémoires de la Société Géologique de France*, vol. 17, mémoire 42, p. 1-86, pls. 1-7.
- Sharpe, D., 1857: Description of the fossil remains of Mollusca found in the Chalk of England. *Cephalopoda*, part 3. *Palaeontographical Society*, London, 1856, p. 37-70, pls. 17-27.
- Wiedmann, J., 1966: Stammesgeschichte und System der posttriadischen Ammonoideen, ein Überblick, 1 Teil. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, vol. 125, p. 49-79, pls. 1-2.
- Wright, C. W. and Kennedy, W. J., 1996: The Ammonoidea of the Lower Chalk, part 5. *Monograph of the Palaeontographical Society*, London, 1996, p. 320-403, pls. 95-124.
- Wright, C. W. and Wright, E. V., 1951: A survey of the fossil Cephalopoda of the Chalk of Great Britain. *Palaeontographical Society*, London, 1950, p. 1-40.
- Zittel, K. A. von, 1884: *Cephalopoda*, in K. A. Zittel: *Handbuch der Paläontologie*, vol. 1, p. 329-522, Oldenbourg, München & Leipzig.